

A SURVEY REPORT ON

WATER POLLUTION IN BISHNUMATI RIVER AREA

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— Researcher

Executive Summary

The holy Bishnumati River starts from the hills of Shivapuri and ends at Teku, where it gets mixed up with another sacred Bagmati River. The studied area includes the section of the river from Indrayani to Teku confluence, an approximate length of 3 kms.

Over the past few years, the river area is being polluted with the disposal of solid wastes in or near the river water. Even the underground water and tap water are contaminated where its chemical parameters exceed beyond the WHO standard. The area is facing the trouble of shortage of pure drinking water, as the people are dependent upon the foul water from these sources, thus bringing out the possibility that many people may become a victim of water-borne diseases.

Even it's not the case that people of the studied area are unaware of water pollution in Bishnumati River. Around 83% (40% aware, 43% know very little) people are aware, to some extent about the water pollution in their area. But still 40% of the people throw their wastes into the river directly. This includes both domestic and industrial wastes. Similarly, the underground water is also getting polluted due to percolation of leachates from the heaps of solid wastes accumulated along the banks of the river and near the shallow wells.

This has had a notable effect upon the people residing in the areas along the banks of the Bishnumati River. Hospital records show that 70% of the total living in the area suffers from the water-borne diseases, with a majority of 34% by diarrhoea, caused by poor sanitation and intake of impure water with E. Coli bacteria. Another effect is the lack of pure drinking water in the studied area and shortage of water for other domestic purposes as well.

Although the effect have been colossal and people are much aware of the ongoing problem of water pollution in their area, still no any significant step has been taken in order to check the water pollution in these areas. Nor anything has been done to improve the condition of water in the Bishnumati River.

It can be concluded that though we have the knowledge of water pollution and its detrimental impacts, and we know about the measures to control water pollution problem in the Bishnumati, but what we still lack is the wisdom, the courage and the compassion to convert this knowledge into a living reality so that we can secure these water resources for future generations to come.

List of Abbreviations

Acronym	Full Form
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DoHS	Department of Health Service
ENPHO	Environment and Public Health Organization
INGO	International Non–Government Organization
NGO	Non–Government Organization
NWSC	Nepal Water Supply Corporation
SAPI	Special Assistance for Project Implementation
USPH	United States Public Health
WHO	World Health Organization

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Introduction

1.1 Background of the Studied Area

The study area is located within the Kathmandu valley, one of the most densely populated inter-montane basins in the mountains. The oval-shaped Kathmandu valley extends about 30 km in the East–West and 25 km in the North–South directions. It occupies an area of about 650 sq. km. Its altitude ranges from 1220–1500 metres above the sea level.

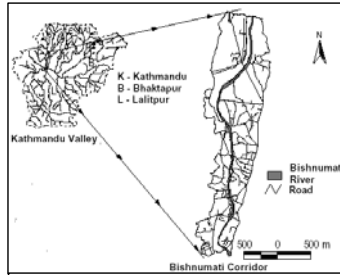


Figure 1 : Location of Bishnumati River

The holy Bishnumati River starts from the foot of Shivapuri hills and ends at the Teku confluence, where it gets mixed up with another holy Bagmati River. The river flows between the altitudes of 2841 m (the origin in the Shivapuri hills) and 1289 m (confluence with the Bagmati River at Teku) above the sea level. Our study area is along the banks of the section of Bishnumati River, beginning from the bridge to Bijeshwori near the Indrayani temple to the Teku confluence where it streams into the Bagmati River. The studied river section of Bishnumati is shown by the bold black curve in the Figure 2 on the next page.

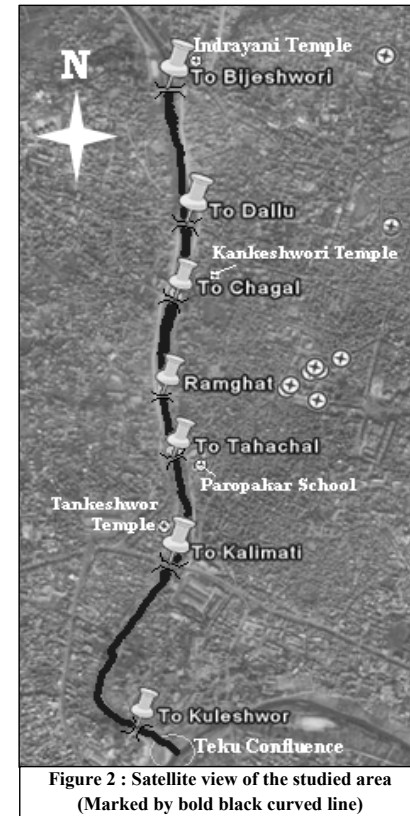


Figure 2 : Satellite view of the studied area
(Marked by bold black curved line)

Geographically, the studied area extends from 27° 41' 29.39" N to 27° 42' 49.37" N latitude (from Teku confluence to bridge towards Bijeshwori) and 85° 18' 07.41" E 85° 18' 08.65" E longitude (from bridge towards Bijeshwori to Teku confluence). The studied section of the river is roughly 1350 m above the sea level. In this stretch the river is 65–100 m wide. The recorded mean monthly flow of this river at Teku confluence is 0.72 m³/sec in March (least) and 16.62 m³/sec in August (maximum). The total

catchment area of this river upstream of its confluence with the Bagmati River is about 80 sq. km. The studied area is roughly 3 km in length.

The studied area contains some Hindu temples, like Indrayani temple, Kankeshwori temple, Tankeshwor temple, etc. There are crematories at Indrayani, Ramghat and Tankeshwor. Similarly, there are some Buddhist chaityas at Chibakhel, near the suspension bridge to Chagal.

There are altogether seven bridges over the studied section of the Bishnumati river— five concrete bridges to Kuleshwor, to Kalimati, to Tahachal, to Dallu and to

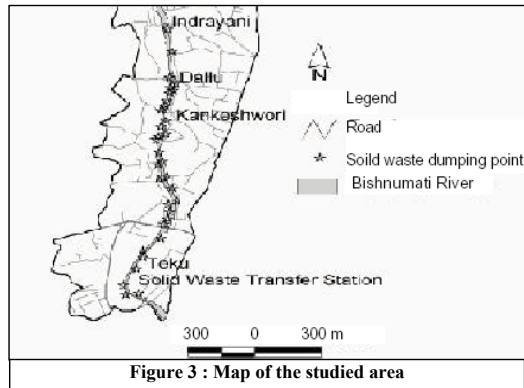


Figure 3 : Map of the studied area

Bijeshwori; one suspension bridge to Chagal and one temporary bridge at Ramghat. *(Bridges have been referred for easy locating of places mentioned.)*

Possessing lots of slaughter houses, paper recycling industries, etc. there have been solid wastes disposal into the river from long past. The banks of the Bishnumati River have become provisional landfill sites, where dumping of solid wastes from Kathmandu started since 1994. The dumping zone extends from Balaju in the north–western part of the metropolis to Teku



Figure 4 : Teku confluence

confluence. The Teku confluence is shown in Figure 4 in which arising from the middle left is Bishnumati River that streams into the right–flowing Bagmati River.

1.2 Statement of the Problems

The year 1994 first saw the start of dumping of solid wastes from Kathmandu along the banks of Bishnumati River.

With poor facilities of sanitation and waste management in the studied area, the wastes are directly discharged into the nearby Bishnumati River, thus polluting the river

water over the past few decades. People say that they used to drink directly from the river water few decades back, now the condition has worsened a lot more due to human activities polluting the river water.

The wastes even from the industries in these areas are also being discharged directly, without any treatment into the river water that adds to the already worsened condition of the Bishnumati River.

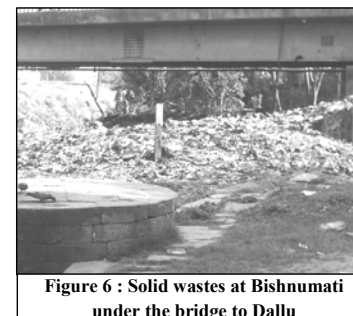


Figure 6 : Solid wastes at Bishnumati under the bridge to Dallu

Other problems can be identified as the pollution of underground water extracted from the wells. The area constitutes of no deep wells but only shallow ones. Hand pumps, which are common one for a locality, have irregular

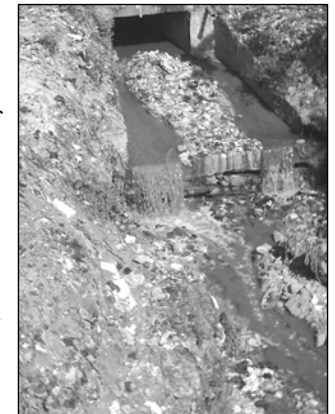


Figure 5 : Picture taken from the bridge to Bijeshwori of the solid wastes being disposed off into the river at Indrayani

water supply and often with foul odour, thus creating a problem of drinking water shortage in the areas from Indrayani to the Teku confluence.

1.3 Objectives of the Study

The objectives of the study are as follows:

- To study about the situation of water pollution along the banks of the Bishnumati River, in Indrayani–Teku section.
- To find out about the causes leading to water pollution.
- To find out the effects caused by water pollution in the residence along the banks of the Bishnumati River.
- To suggest possible remedies to check the level of water pollution in the studied area.

1.4 Definitions of the Terms

BOD It is an acronym for Biological Oxygen Demand, referring to the measurement of the biological pollution present in the water. This is obtained by measuring the amount of oxygen absorbed from the water by the microorganisms present in it.

COD It is an acronym for Chemical Oxygen Demand, referring to the measurement of the chemical pollution present in the water. This is obtained by measuring the amount of oxygen absorbed from the water by the chemicals contained in it.

Coliform They are rod-shaped bacteria that are normally found in the colons of humans and animals, and become a serious contaminant when found in the food or water supply.

DO It is an acronym for Dissolved Oxygen. It refers to the amount of oxygen dissolved in the water, stored in the intermolecular space of the water molecules.

E. Coli *Escherichia Coli*, a bacteria species and a causative agent for water-borne disease, mostly diarrhoea.

Leachate It is a liquid solution that comes from the solid wastes after leaching process.

Chapter 2

Review of Literature

2.1 Review of Theories and Previous Studies

Previously studies have been done as regards to the status of water pollution in Kathmandu valley. The first helpful research project was entitled **"Impact of solid waste on water quality of Bishnumati River and surrounding areas in Kathmandu, Nepal"**, a combined work of Dinesh C. Devkota and Kunio Watanabe, from Saitama University of Japan. Following is the data of pollution status at various points of Bishnumati River as collected by them:

Locality	Tokha	Naya Bazaar	Dhalko	Dhobighat
Source	Tubewell	Tubewell	Tubewell	Dug well
Sample depth, m	5.49	6.71	3.66	3.35
Geographical location	27°40'23.3" N	27°43'25.8" N	27°42'42.7" N	27°40'28.6" N
	85°18'45.2" E	85°18'14.2" E	85°18'10.4" E	85°17'42" E
Altitude	1336 m	1283 m	1311 m	1266 m
Parameters				
Temperature (°C)	19.00	19.2	20.2.0	20.40
pH	6.4	6.4	6.50	6.60
Conductivity (μS/cm)	521.00	807.0	1009.00	842.00
Ammonia (mg/l)	1.60	4.5	3.00	6.80
Nitrite (mg/l)	0.12	0.542	1.00	1.07
Nitrate (mg/l)	0.13	0.725	0.20	0.81
Phosphate (mg/l)	0.03	0.024	0.02	0.196
Iron (mg/l)	2.54	1.74	2.33	1.07
Manganese (mg/l)	0.40	0.06	0.51	0.88
Nickel (mg/l)	0.01	0.018	0.015	0.016
Copper (mg/l)	< 0.01	0.14	< 0.01	< 0.01
Zinc (mg/l)	0.13	0.25	0.10	0.16
Chromium (mg/l)	< 0.01	< 0.01	< 0.01	< 0.01
Cadmium (mg/l)	0.0012	0.0017	< 0.001	0.0013

Table 1 : Results of water quality analysis carried out in May 2004

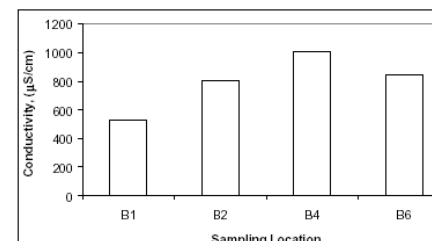


Figure 7 : Column-Chart showing conductivity in shallow wells

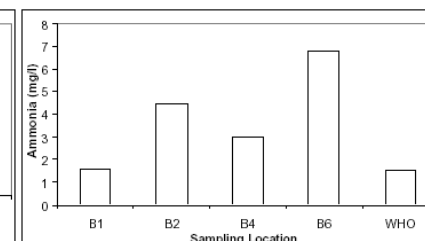


Figure 8 : Column-Chart showing ammonia concentration in shallow wells

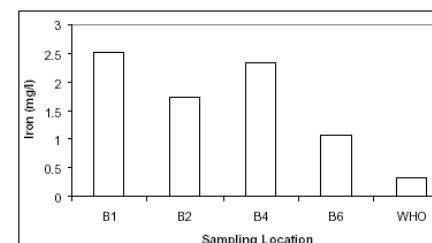


Figure 9 : Column-Chart showing iron concentration in shallow wells

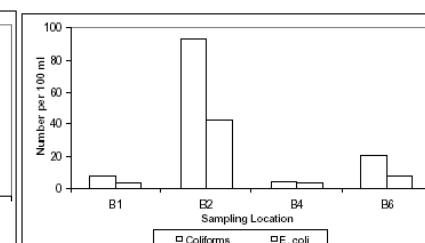


Figure 10 : Column-Chart showing microbial contamination in shallow wells

Legends :

B1 = Tokha, B2 = Naya Bazaar, B3 = Shobha Bhagwati, B4 = Dhalko, B5 = Teku, B6 = Dhobighat

Leachate composition compared of the year 1994 and 2004, in the study, is presented below:

Parameters	1994, Leachate at different location points				2004
	L1	L2	L3	L4	Shobha Bhagwati
pH	7.53	6.82	7.2	8.01	7.5
Conductivity (μS/cm)	8790	1291	229	780	40930
Nitrate, mg/l	2.7	0.35	0.31	11.86	3.25
Nitrite, mg/l	0.02	0.03	0.1	2.25	<0.02
COD, mg/l	3205	517.4	18.8	28.2	811.5
Phosphate, mg/l	0.3	0.16	0.1	0.3	8.6
Copper, mg/l	0.14	0.01	< 0.005	< 0.005	0.042
Iron, mg/l	9.1	8.4	2.58	0.2	1.9
Manganese, mg/l	3.8	2.5	0.3	0.1	0.42
Lead, mg/l	0.28	0.03	< 0.005	< 0.005	0.015
Cadmium, mg/l	0.01	< 0.005	< 0.005	< 0.005	0.0018
Chromium, mg/l	1.06	0.2	9.09	0.09	0.017
Nickel, mg/l	0.13	< 0.01	< 0.01	< 0.01	0.04
Zinc, mg/l	0.65	0.11	0.06	0.06	0.23

Table 2 : Table comparing leachate in 1994 and 2004

Source: Sharma et al. (1995) and Devkota (2004)

Another study shows comparative study of water from various sources in

Kathmandu Valley:

Parameters	Unit	Tap Water	Ground Water
Chloride	mg / l	5 to 12	610* to 1100*
Nitrate	mg / l	18 to 48	27* to 58*
Sulphate	mg / l	1 to 3	61 to 92
BOD	mg / l	1.5 to 3	2 to 12*
pH	6 to 8.5	6 to 8.9	—
Hardness salts	mg / l	10 to 35	230 to 750
Table 3 : Table showing the chemical parameters of tap and groundwater in Kathmandu valley			
*values exceeding WHO Standards		Source : IUCN, 1991	

The drinking water demand in the Kathmandu valley in 2011 and 2016 are projected by another study, **"Delivering Water to the Poor"**(2005) by NGO Forum for Urban Water and Sanitation, based on 2001 and 2006 data:

	2001	2006	2011	2016
Average daily per capita consumption	74	78	86	92
Average daily demand	146.6	183.9	207.8	268.3
Table 4 : Table showing the demand for water in the Kathmandu valley				
Source : SAPI II on Melamchi Water Supply Project, February 2004				

Research Methodology

3.1 The Research Design

The research design for this study is chosen to be investigative and vivid. This study will help identify the situation of water pollution in the sacred Bishnumati river from Teku confluence to Indrayani, identify the causes of the water pollution in these areas, identify the effects on the local people due to the pollution of the river and work out the possible solutions that needs to be taken as soon as possible to mitigate these effects.

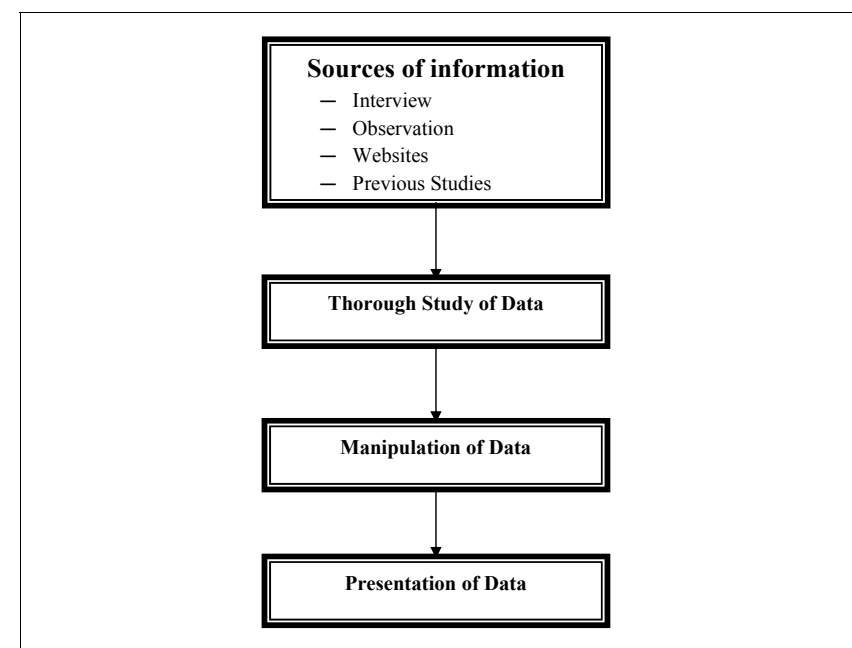


Figure 11 : The Research Design

3.2 Nature and Sources of Data

We have collected two types of data, viz. the primary and the secondary data. Data as regards to water pollution in Bishnumati River were collected by different methods of data collection, viz. interview schedule and observation. And secondary data were collected through previous studies, encyclopedias, from government offices, internets, etc.

3.3 Universe and Sampling

Local people, who are the possible victims of water pollution in Bishnumati River, workers of local industries, different organizations (government, local NGOs and INGOs), persons related to these organization and other local experts are the universe of the study. In this study a total of 30 peoples residing near the Bishnumati River at Teku, Kalimati, Tankeshwor, Kankeshwori, Bijeshwori and Indrayani have been interviewed to find out about the causes, effects and possible remedies of the water pollution in the Bishnumati River.

3.4 Data Collection Technique

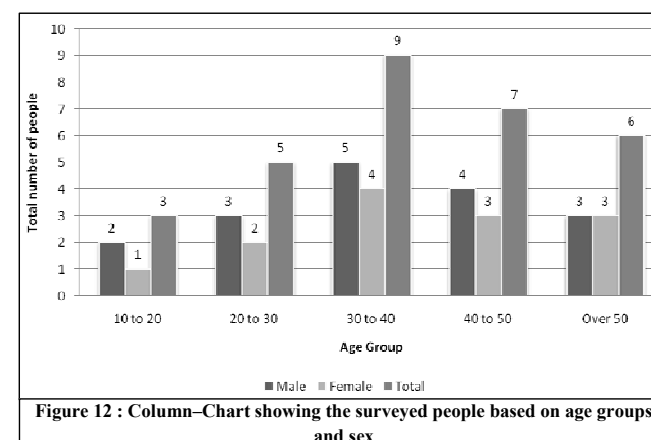
After the assignments were given and the topics were selected, we collected as many facts and data as possible regarding water pollution through

websites, encyclopedias, previous studies and many other publications about the Bishnumati River and Kathmandu valley.

Then field visits were made to the Bishnumati River, observing the status of water in the river. We even walked for days along the banks of Bishnumati River, from Teku confluence to Indrayani, interviewing local people of the effects that water pollution has brought upon them. Observation based on the waste disposal of different small scale industries of the area has also been noteworthy in the collection of data.

3.4.1 Primary Data

It's the type of data collected directly from the sources. The interviews taken in preparing this report are example of this type of data. Moreover, the information collected from discussion is also primary data.



3.4.1.1 Interview Schedule

Interviews were conducted among 30 people from diverse areas along the banks of the river and diverse economic backgrounds, so as to include ideas from diverse population in this report. Interview questionnaires focused on the causes, present scenario, effects and possible remedies to control the ongoing water pollution in Bishnumati River, classified as the primary data for the report.

3.4.1.2 Observation

By observing the polluted banks along the Bishnumati River we came to know about the situation of the studied area. With solid wastes being thrown directly into the river, sewage pipes connected to the river, people throwing their household wastes into the river, etc the Bishnumati River is getting polluted day by day.

3.4.2 Secondary Data

Secondary data refers to such type of data collected from previous reports, studies and documents. This is only a reference to our study providing information of what previous experts say. It has been very resourceful in proving our research data and for the preparation of charts and graphs.

3.5 Data Processing and Analysis

Data tabulation and preparation of bar charts and pie-charts were some of the techniques used for processing of data. Data, gathered from various sources, were tabulated and sorted for easy processing. The data collected from the questionnaires were also tabulated.

The numerical figures in tables were converted into its equivalent percentage value so as to show the trend of pollution activities in the river in average. The figures were fed to computer to produce different charts that are presented in this report for easy analysis. Each figures, charts and tables were presented, interpreted and concluded as well in the most comprehensible form as far as possible.

3.6 Limitation of the Study

The research is unable to provide in-depth study of water quality owing to the chemical impurities, biological invasions, and the BOD, COD and DO level. However attempts have been made to fulfill such deficiencies by the secondary data, from various researchers of the past. But this might have fluctuated to a greater extent in the recent days.

The interviewed people are also limited in front of over hundred households. Only 30 have been interviewed due to the constraint of time. But still people of diverse backgrounds have been interviewed to represent all.

Presentation and Analysis of Data

4.1 Situation of Water Pollution in the Studied Area

We could see the worsening scenario of Bishnumati River just by walking along the banks of the river section from Indrayani to Teku confluence. Firstly the river water

is being so much polluted by the mixing of sewage pipes into the river directly and by human activities like disposing their household and industrial wastes



Figure 13 : Water Pollution at Kankeshwori

directly into the holy Bishnumati River. Obviously, this water is now unfit for any domestic uses because of the increased level of pollution.

Similarly, the surveyed people say that the drinking water being supplied in the studied area is turbid and foul smelling. This suggests another problem of the underground water pollution in these areas. The communal hand pumps in the area also gives foul smelling water, unfit for domestic purposes.

Another water source, the shallow wells have often polluted and turbid water and people residing in these areas are compelled to use such water, even if they know of the possible harmful effects of such polluted water.

The situation of the water pollution can be better known by studying the effects this has had in these areas. People often get victimized by water-borne diseases, like diarrhoea, jaundice and typhoid. Two nearby,



Figure 14 : Teku Hospital

mostly visited hospitals have been referred for the study, viz. **Shukra Raj Tropical and Communicable Disease Hospital** (better known as **Teku Hospital**) and **Bir Hospital**.

Water-borne diarrhoea tops the ratings of the leading diseases among the in-patients in the fiscal year 2061/62 at Teku Hospital, constituting 2,967 patients. Poisoning of polluted water comes in top five in the same fiscal year at Bir Hospital, constituting 223 in-patients.

Bir Hospital has 4,355 out-patients and 297 in-patients. Teku Hospital

has 440 out-patients and 111 in-patients of water-borne diseases. Figure 15 shows diarrhoea as the most common disease among the patients at these hospitals in the fiscal year 2061/62, constituting 62% of total patients of water-borne diseases.

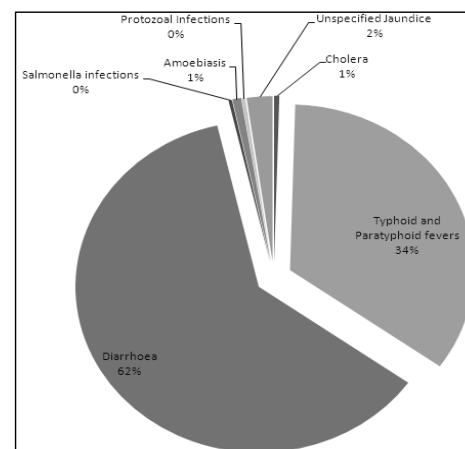


Figure 15 : Pie-Chart showing the patients of different water-borne diseases at Bir Hospital and Teku Hospital in the fiscal year 2061/62

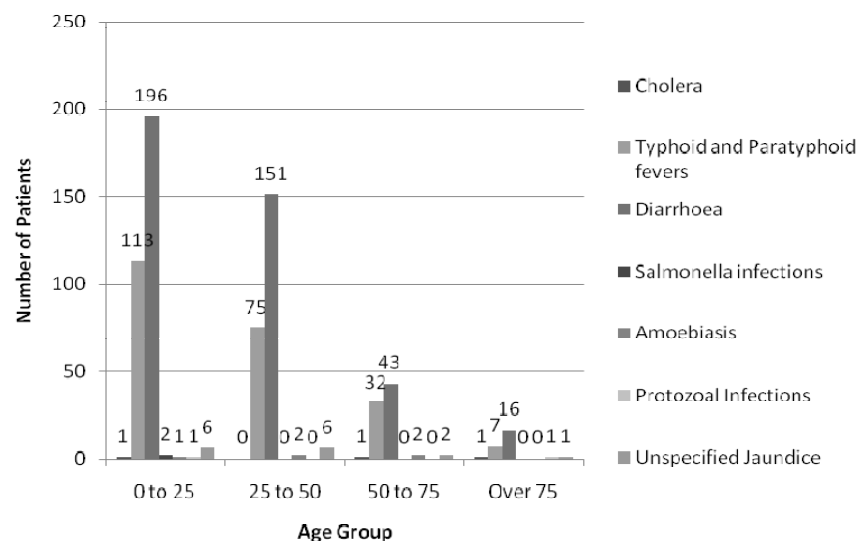


Figure 16 : Column-Chart showing the total number of patients of different water-borne diseases by age group at Bir Hospital and Teku Hospital in the fiscal year 2061/62

4.2 Causes of Water Pollution in the Studied Area

Water pollution is caused by various human activities like throwing wastes from household or industries directly into or near the river, connection of sewage pipes in river, bathing animals in or near the river, etc. The sanitation pipes of most of the parts of Kathmandu city open up at the Bishnumati River and Bagmati River rendering it unfit for any uses.

Other small scale paper recycling industries along the banks of Bishnumati River at Tahachal – Chagal section decomposes their wastes in the river water. Some of them burn the wastes near the river and throw the ashes in the river polluting even more the already polluted Bishnumati River.

Major causes of water pollution in the studied area are identified as:

4.2.1 By Domestic Wastes Discharged into the River

Majority of the surveyed people throw their wastes into or near the Bishnumati River, constituting 12 people of total surveyed, which sums up to 40%. This constitutes of age

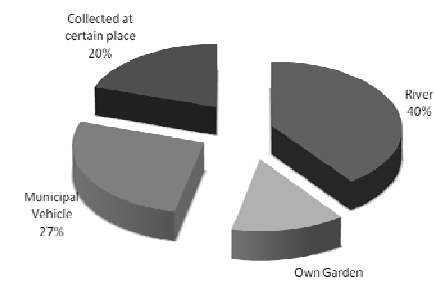


Figure 17 : Pie-Chart showing the solid waste disposal by the surveyed people

group 10–20 and 30–40 mostly (as seen in Figure 17 and 18), which has been a leading factor for the water pollution in Bishnumati River at the studied section of Indrayani to Teku confluence. Similarly, only 4 people decompose their wastes in their own garden, which constitutes of only 13% of the total surveyed.

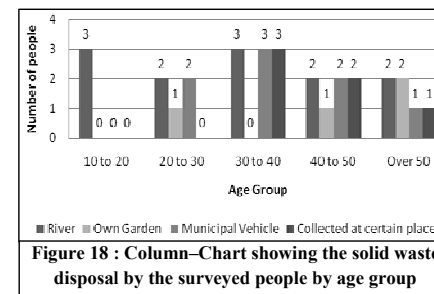


Figure 18 : Column-Chart showing the solid waste disposal by the surveyed people by age group

Among the surveyed, Krishna Bahadur Fuyal said, "We haven't thrown the wastes into the river because one would never throw his/her wastes in his privy." His

small hut is less than a meter from the water of Bishnumati at Chagal. He adds, "People from nearby places throw their wastes into the river— we hear every morning from 4 to 6. Also people defecate in river at nights."

Another of the surveyed, Naramaya Shahi, distributor of wooden materials at Bijeshwori, said, *"Even the municipal vehicles throw their wastes they into the river, especially under the bridge at Indrayani."*

A butcher at Teku, Thule Kasaai, says that he has to slaughter around 2 or 3 ox a day. He added, *"We throw all the wastes including the inedible parts of the animal into the river, for it's near and an easy way out."*

There is no proper sewerage system in the Kathmandu valley since only 15% of the houses have access to sewerage facility. (NWSC 1999)

Analysis of domestic waste, based on Tebbutt (1992) shows that if an average of 50g BOD/person/day is produced in Kathmandu valley, it will produce 50,000 kg BOD/day from one outlet, constituting 42% of total BOD load produced by the valley's people. (CEMAT 2000)

Location	Country Total	Kathmandu valley	% of total units in the valley
Total industrial units	4271	2174	50.9
Water polluting industrial units	1714	1241	72.4

Table 5 : Water pollution units compared to Total Industrial Unit (1992)

Sources : Devkota and Neupane (1994)

The above table shows that the Kathmandu valley hosts more than 72% of the country's water polluting industries. The study of Devkota and Neupane indicates that the contribution of industrial effluents to the rivers is about 7% of the total effluents (domestic and industrial) in the Kathmandu valley.

The groundwater quality in the Kathmandu valley is also contaminated due to polluted surface water, leachate and sewage. None of the water from groundwater sources is guaranteed free from faecal contamination (ENPHO, NWSC 1999). The studies of ENPHO (2000), CEMAT (1999) and Jha et. al. (1997) indicated that the concentration of ammonia-N in deep wells is above WHO standard and nitrate-N concentration is also higher in shallow and dug wells than WHO standard.

Faecal coliform / 100 ml	Value as % of sample units of 15							WHO guideline value
	Dug well	Shallow well	Deep well	Spring	Stone spout	Pond	Piped water	
0	0	60	80	40	20	0	60	0
1 – 100	40	30	15	30	40	0	20	–
101 –1000	30	5	5	30	40	0	20	–
> 1000	30	5	0	0	0	100	0	–

Table 6 : Bacteriological water quality from different sources, Kathmandu valley

Sources : ENPHO (1999); NWSC (1999)

4.2.2 By Industries

The small scale paper recycling industries in the studied section of the Bishnumati River, from Indrayani to Teku confluence, have been throwing their industrial wastes into or near the river. Figure 19 shows Mr. Bishnu Dhwoj Shahi, one of the 30



Figure 19 : A man throws wastes of paper recycling industry at Kalimati

surveyed, throwing the wastes from a local small scale paper recycling industry at Kalimati. As we looked on, he burned these wastes and after burning them, threw them into the river before we could stop him.

Sukumaiya Lama, another worker of paper recycling industry surveyed at Ramghat, said, *"We have a system of collecting wastes especially at nearby Municipality office of Teku. But at night we have no place other than Bishnumati River to throw the wastes."* She even complained of the foul liquid from the long-accumulated solid wastes (leachate), which she threw into the river innocently. *"The paper recycling industries generate around 4–5 kg of wastes on a daily, most of which are directly thrown into the river or burnt near the river,"* said Bishnu Dhwoj Shahi.

Similarly, seller of wooden materials at Bijeshwori, Naramaya Shahi, said, *"We have much saw dusts coming when we cut woods to produce any material and give it a proper shape. But we have no place to decompose it. So it's better to throw it in river to get rid of those wastes."* Another seller of wooden materials at Bijeshwori, Sunil Mahat, said, *"We have much waste to be thrown and it's easy for us to throw them into the already polluted Bishnumati River."* Ajij Ansari, searcher of golds at Bishnumati River said, *"While collecting solid particles from the river, we most often get wastes packed in the plastic bags."*

Thus, also due to the unmanaged and untreated industrial wastes disposal into the river, the water quality in the Bishnumati River is getting deteriorated day by day.

4.2.3 Others

Other causes of water pollution can be regarded as solid waste disposal near the Bishnumati River along the banks especially. Figure 20 shows a boy working in one of

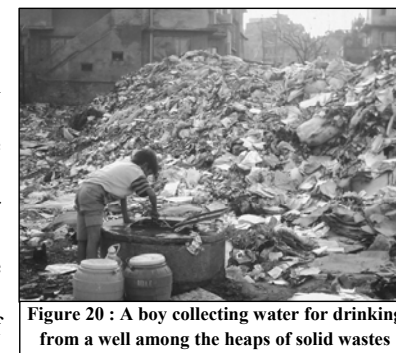


Figure 20 : A boy collecting water for drinking from a well among the heaps of solid wastes

the paper recycling industries, Ganesh Rauniyar, collecting water for drinking from a shallow well at Ramghat. Having recently suffered from diarrhoea, he has no other sources of drinking water except this well, at some metres length from his house. Talking of the water of the well, he said, *"The water often has a foul smell with it. At times of rain, the water from this well is not usable at all."*

But, the case is quite good with the water pumps in these areas. Figure 21 shows two hand pumps, the left one is said to be communal and the right one a private. *"Water is supplied once in two days especially in the morning, and is at times foul and unusable for any purposes,"* said Sijan

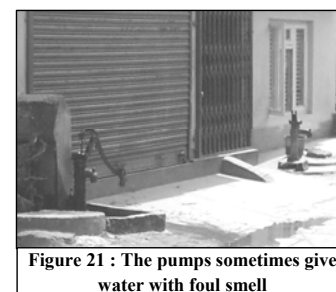


Figure 21 : The pumps sometimes give water with foul smell

Chhetri, a resident of Teku. Another hand pump at Kankeshwori hardly gets supplied with water. The hand pump is very near to the Bishnumati River and its water often has visible impurities with it.

4.3 Knowledge about Water Pollution among the people of the Studied Area

People of studied area seem know, to some extent about water pollution. 12 know about water pollution, this is 40% of surveyed. This covers all the age groups that were surveyed. 'Yes' pie in the Figure 23 represents those who know about the causes and some possible effects of water pollution. This constitute majority from the age group 20–30.

13 know very little about the water pollution, this is 43%. 'Very Little' pie represents this group containing all the age groups, with majority from the age group 30–40.

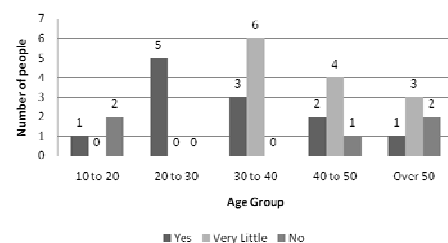


Figure 22 : Column-Chart showing the knowledge status of the surveyed people about water pollution by age group

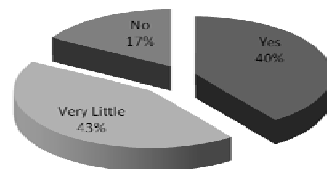


Figure 23 : Pie-Chart showing the knowledge status of the surveyed people about water pollution

'No' constitutes 3 people that is 17%. Their knowledge is restricted to the fact that wastes mustn't be thrown into river, and don't know of causes, except for wastes thrown by the local people. This group has no knowledge of harmful effects of water pollution. This constitutes 2 each from 10–20 and over 50 and one from 40–50 age group.

Summary, Conclusion and Findings

5.1 Summary and Findings

The survey shows that over 40% of the surveyed people throw their wastes, both domestic and industrial wastes, directly into the river water. This is the major factor that has led to the pollution, to a greater extent, in the holy Bishnumati River.

Survey done to find out recent illness of oneself or his/her relatives, friends or family shows a higher percentage of people knowing and/or being the victims of water-borne diseases. With 21 people knowing and/or being victims of water-borne diseases, the percentage of being affected by water borne disease in the area comes out to be 70%.

Among the surveyed 10 suffered from diarrhoea, which sums up to be

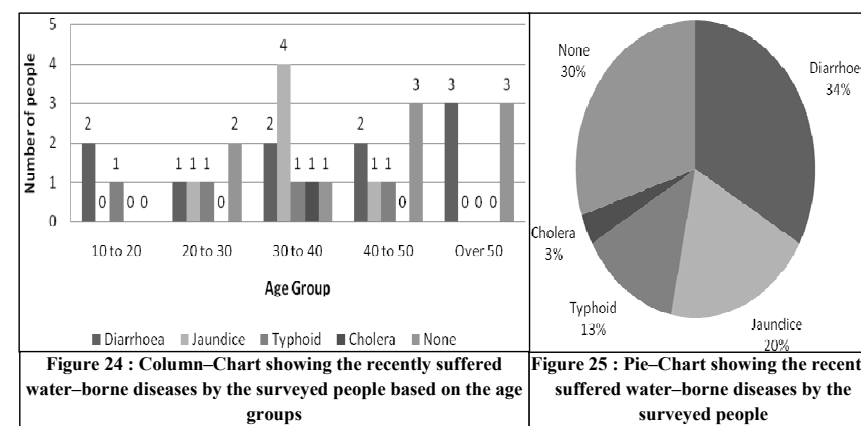


Figure 24 : Column-Chart showing the recently suffered water-borne diseases by the surveyed people based on the age groups

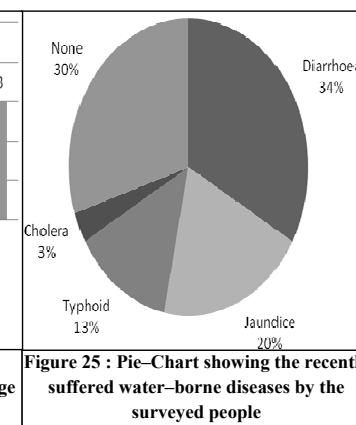


Figure 25 : Pie-Chart showing the recently suffered water-borne diseases by the surveyed people

34% of total surveyed, with majority from over 50 and 10–20 age groups.

Diarrhoea is found to be the most common water–borne disease that has affected the people residing along the banks of Bishnumati River along the banks from Indrayani to Teku confluence.

Jaundice is suffered by 6 people, which come out to be 20% of the total surveyed. Jaundice sufferers are more commonly known by the age group of 30–40. 4 people from this age group know of at least a person suffered by this disease.

Typhoid is known to have victimized 4 people that are 13% of total surveyed. Typhoid is found among all age groups from 10 to 50.

And cholera is known to have been suffered by one that is 3% of total surveyed. Gayatri Khadgi of Tankeshwor had her sister affected by this dreadful water–borne disease.

Remaining 9 people haven't been affected by such water–borne diseases at recent times. This constitutes 30% of the total surveyed people. People of over 50 are found to be free of any of the water–borne diseases recently.

But the possibility of being affected by water–borne diseases still remains 70%, with a majority being a victim of diarrhoea (48% of total victimized by the water–borne diseases).

5.2 Conclusion

The studied area along the banks of the sacred Bishnumati River section from Indrayani to Teku confluence is visibly polluted, both scenically and environmentally. Although efforts are told to be in progress regarding the cleanliness of the river and sanitation of river banks, still they do not suffice the needs of the today to control the water pollution.

Age Group →	0 to 25			25 to 50			50 to 75			Over 75			Total
Diseases ↓	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Amoebiasis	1	0	1	1	1	2	1	1	2	0	0	0	5
Cholera	1	0	1	0	0	0	0	1	1	0	1	1	3
Diarrhoea	101	95	196	67	84	151	18	25	43	7	9	16	406
Protozoal Infections	1	0	1	0	0	0	0	0	0	1	0	1	2
Salmonella infections	1	1	2	0	0	0	0	0	0	0	0	0	2
Typhoid and Paratyphoid fevers	55	58	113	25	50	75	17	15	32	4	3	7	227
Unspecified Jaundice	3	3	6	3	3	6	1	1	2	1	0	1	15
Table 7 : Table showing the patients of water–borne diseases at Bir Hospital and Teku Hospital													

40% of the people throw their wastes opening the possibilities of approximately 70% people being affected by water–borne diseases. This shows how fast the effects of water pollution aggrandize. The most popular disease is diarrhoea affecting 34% of total surveyed, caused due to intake of unhygienic and impure drinking water, and improper sanitary conditions.

Talking of the knowledge status, only 17% don't know about the water pollution limited under 20 age group. Remaining 83% know more or at least something of water pollution. But still nothing or very least are done to save and to control water pollution in the Bishnumati River.

It can thus be concluded that although we have the knowledge regarding the water pollution and its harmful impacts, and we know about the possible measures to control this ongoing water pollution problem in the Bishnumati River (and other rivers of Kathmandu valley as well), but what we still lack is the wisdom, the courage and the compassion to convert this knowledge into a reality so as to secure these water resources for future generations.

5.3 Recommendations and Suggestions

With rapid rate of water pollution in the studied area along the banks of the Bishnumati River in Indrayani–Teku section, there are lots to be done to check the water pollution level in the studied area. Some possible recommendations and suggestions as obtained in interview, and obtained as secondary data from various sources are prescribed below:

- The first and foremost thing that needs to be done to control the water pollution in and near the Bishnumati River is to make the people manage their wastes themselves. This can be achieved by setting up waste disposal pits or manure pits to collect wastes and make compost of it.

This can to some extent reduce the volume of wastes that would otherwise be thrown into the river.

- Sewage pipes that have been opened up in the river need to be diverted elsewhere perhaps collected inside two or more huge pits, to convert it into compost manure or any other techniques as possible.
- The throw of solid wastes into the river water need to be checked in order to avoid biological invasion in the river and underground water.
- Solid waste disposal near the river water, from where leachates infiltrate into the underground water and pollutes it, need to be disposed properly and not into the river.
- Human and animal faeces thrown in these areas can be better used to produce bio–gas. In fact a small scale bio–gas plant already exists at Kankeshwori but this has remained unused since a long time.
- Cleaning the river water is a must to save the scenic beauty and water ecology. This can be done in three phases, viz. primary treatment, secondary treatment and tertiary treatment. Primary treatment treats water physically (separates grits and solid wastes), secondary treatment treats it biologically (microbes decomposes the small particles solid wastes) and tertiary treatment treats it chemically (in oxidation ponds).

- Although this had been done in past, but the treatment plants are, to some extent, unused at present. These plants need to be repaired or reconstructed so as to control the pollution level of the Bishnumati River.
- Establishing parks or recreational places (as done to some extent at Kankeshwori near the suspension bridge to Chagal) to avoid the pollution by human activities in such places.
- Planting trees along the banks of the river so as to preserve the scenic beauty of the river and its surrounding areas.
- Making the people aware of possible harmful effects of water pollution.
- Proper laws need to be made against throwing wastes into the river.
- Setting proper standards for the local paper recycling industries to treat their wastes themselves rather than throwing their wastes directly into river.
- Proper implementation of the laws and checking their implementation status as measures for water pollution.

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Appendix

Table 8: Survey List Database

S. N.	Name	Age Group	Sex	Address	Business	Waste Disposal	Knowledge about water pollution	Recent illness by water pollution
1	Ajij Ansari	30–40	M	Bijeshwori	Gold searching	Municipal Vehicle	Little	Diarrhoea
2	Badri Pradhan	30–40	M	Chagal	Job	Municipal Vehicle	Yes	Jaundice
3	Bekha Bahadur Shahi	30–40	M	Kankeshwori	Job	River	Little	Jaundice
4	Bishnu Dhwoj Shahi	>50	M	Kankeshwori	Paper Recycling	River	No	–
5	Deevakar Bhattarai	20–30	M	Teku	–	Municipal Vehicle	Yes	Jaundice
6	Devi Pradhan	30–40	F	Teku	Housewife	Collected at certain place	Yes	Jaundice
7	Dhan Kunwar	40–50	M	Teku	–	Collected at certain place	Little	–
8	Dil Bahadur Shahi	40–50	M	Kankeshwori	Job	River	Little	Jaundice
9	Ganesh Rauniyar	10–20	M	Ramghat	Paper recycling	River	No	Diarrhoea
10	Gayatri Khadgi	30–40	F	Tankeshwor	Housewife	River	Little	Cholera
11	Hari Dangal	40–50	M	Dallu	Job	Municipal Vehicle	Yes	–
12	Jaudha Bahadur Shahi	40–50	M	Kankeshwori	Job	Municipal Vehicle	Yes	Diarrhoea
13	Krishna Bahadur Adhikari	>50	M	Teku	–	Collected at certain place	Yes	Diarrhoea
14	Krishna Bahadur Fuyal	>50	M	Chagal	–	Own Garden	Little	–
15	Machanani Maharjan	40–50	F	Bijeshwori	Housewife	Own Garden	Little	–
16	Maiya Nepali	30–40	F	Bhimstenhan	Housewife	Municipal Vehicle	Little	Diarrhoea
17	Maya Khadgi	10–20	F	Kalimati	Student	River	Yes	Typhoid
18	Naramaya Shahi	40–50	F	Bijeshwori	Wood	River	No	Typhoid
19	Navindra Khadgi	10–20	M	Tankeshwor	Student	River	No	Diarrhoea
20	Radha Shahi	>50	F	Kankeshwori	Housewife	River	No	Diarrhoea
21	Ram Krishna Neupane	30–40	M	Teku	Job	Collected at certain place	Little	Typhoid
22	Ratna Chhetri	20–30	F	Kalimati	Student	Own Garden	Yes	Diarrhoea
23	Sanu Maya Pradhan	30–40	F	Chagal	Housewife	Collected at certain place	Yes	Jaundice
24	Shreya Kugar	20–30	F	Tahachal	–	Municipal Vehicle	Yes	–
25	Sijan Chhetri	20–30	M	Teku	Student	River	Yes	Typhoid
26	Sudha Shahi	>50	F	Kankeshwori	Housewife	Municipal Vehicle	Little	Diarrhoea
27	Suku Maiya Lama	40–50	F	Ramghat	Paper Recycling	Collected at certain place	Little	Diarrhoea
28	Sunil Mahat	20–30	M	Bijeshwori	Wood	River	Yes	–
29	Thule Kasai	30–40	M	Teku	Slaughter	River	Little	–
30	Thuli Fuyal	>50	F	Chagal	Housewife	Own Garden	Little	–

Water Quality Parameters and Standards Prescribed by USPH

	Parameters	USPH Standard
Physical Characteristics	Colour	Colourless
	Odour	Odourless
	Taste	Tasteless
	pH	6.0 – 8.5
	Specific Conductance	300 $\mu\text{mho cm}^{-1}$
	Dissolved Oxygen (D. O.)	4.0 – 6.0 (ppm)
	Total dissolved solids	500
Inorganic Chemicals	Suspended solids	5.0
	Chloride	250
	Sulphate	250
	Nitrate + Nitrite	< 10
	Fluoride	1.5
	Phosphate	0.1
	Sulphide	0.1 mg L^{-1} (ppm)
	Ammonia	0.5
	Boron	1.0
	Calcium	100
	Magnesium	30
	Arsenic	0.05
	Barium	1.0
	Cadmium	0.01
	Chromium	0.05
	Copper	1.0
	Iron	< 0.05
	Lead	< 0.05
	Manganese	< 0.05
	Mercury	0.001
	Selenium	0.01
	Silver	0.05
	Uranium	5.0
	Zinc	5.5
Organics	Chemical Oxygen Demand (COD)	4.0
	Carbon	0.15
	Methylene blue active substances	0.5
	Phenols	0.001
	Pesticides (total)	0.005
	Polycyclic aromatic	0.002
	Hydrocarbons (PAH) surfactants	200
Radioactivity	Gross beta	1000 Bq L^{-1}
	Radium	3 Bq L^{-1}
	Strontium – 90	10 Bq L^{-1}
Bacteriological Parameters	Coli form cells / 100 ml	100
	Total bacteria count / 100 ml	1 $\times 10^6$
Table 9 : Permissible limits of drinking water prescribed by USPH		

Interview Questionnaires

1. How much wastes is generated by your family ?
.....
2. How do you manage these wastes from your house / industry ?
☐ Throw into the river ☐ Own Garden
☐ Municipal Vehicle ☐ Collected at certain place
3. Is there any steps being taken to minimize water pollution in your area ?
☐ Yes ☐ No
4. If yes, who has been involved in taking these steps ?
.....
5. If yes, how fruitful do you feel such steps have been so far ?
.....
6. Is there any recent illness that you or your family has suffered due to water pollution ?
☐ Yes ☐ No
7. If yes, what is the disease that you recently suffered from ?
.....
8. Is there the facility of water supply in your area ?
☐ Yes ☐ No
9. From where do you collect the drinking water in your area ?
☐ Own water pump ☐ Communal hand pump
☐ Well ☐ Others : (Pls. specify)
10. How often is drinking water supplied in your area ?
.....
11. How clean is the water supplied in your area ?
☐ Very clean ☐ So – so
☐ Usable for household but not drinkable ☐ Not drinkable at all